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HISTORY OF THE MK 52 WARHEAD (U)

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History of the Mk 52 Warhead

The Mk 52 resulted from the effort to provide the Army SERGEANT rocket with an appropriate nuclear warhead. An early meeting was held September 25, 1953, with representatives of the missile contractor (the Jet Propulsion Laboratory of the California Institute of Technology), the Armed Forces Special Weapons Project and Sandia in attendance. It was noted that the SERGEANT would be 30 inches in diameter, 35 feet long, weigh 10,000 pounds, and be able to carry a 1500-pound warhead to a range of 75 to 100 miles. The SERGEANT was a surface-to-surface, solid-propellant guided rocket, intended as a replacement for the CORPORAL, which carried a Mk 7 Warhead.[1]

The Division of Military Application, in a letter dated November 27, 1953, noted that the SERGEANT had not yet been approved as an atomic weapon carrier, and that Sandia participation should be limited to liaison and interchange of information to assist the Jet Propulsion Laboratory in preparing a system proposal.[2]

Little immediate warhead work was performed, but by late May 1955 Sandia studies indicated that it would be possible to provide a warhead to meet missile requirements of reliability, simplicity, ease of operation, freedom from countermeasures, ruggedness and safety. A thermonuclear design was suggested, since the higher yield and efficiency of such weapon would have size and weight advantages that would aid in achieving missile objectives.[3]

The Assistant Secretary of Defense notified the United States Atomic Energy Commission August 29, 1955 that early production of the SERGEANT missile was scheduled for May 1959. Request was made for participation in a joint feasibility study of suitable warheads for the system, in cooperation with the Army and the Armed Forces Special Weapons Project, and this request was subsequently forwarded to both Santa Fe and San Francisco Operations Offices.[4]

By mid-April 1956, two successful SERGEANT flight tests had taken place. The rocket was inertially guided, and continuous guidance correction during the missile flight

was provided. The range was controlled by extending the drag brakes of the missile for a specified length of time.

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The Army's Picatinny Arsenal had been studying possible fuzing systems and proposed that a radiating-type fuze be used, with options of air burst with contact backup, ground burst, and air burst with contact preclusion. It was felt that either inertial or barometric fuzing would not be sufficiently precise, as it was hoped to develop a burst-height accuracy of ±50 feet.

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A feasibility study group had meanwhile been formed, with representatives from Field Command, Picatinny Arsenal and Sandia. This group reported, July 25, 1956, that it would be about a year and a half before firm atomic-warhead information would be required for the SERGEANT program, and that consideration of warhead designs was premature. It was proposed that warhead selection, as well as completion of the feasibility study, be deferred until after the 1957 nuclear test series.[6]

Picatinny Arsenal requested information on the one-point-detonation characteristics of the nuclear design, so that an adequate safing system could be devised.

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Rocket design continued, with little work being done on the warhead. The feasibility study group again met December 3-4, 1957, and learned that the rocket operational availability date of mid-1962 might be shortened by almost a year.

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Picatinny Arsenal released the feasibility study report December 31. 1957.

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Typical targets were fighter airfields, command posts, headquarters, communication centers, supply and logistic installations, troop units, tanks and artillery.

The rocket was 31 inches in diameter, 31 feet long, and weighed 10,000 pounds at launch. It was composed of four major sections; propulsion, fins, guidance and warhead. The solid-propellant motor had a burning time of 28 seconds and reached a peak longitudinal acceleration of about 10 g's at burnout. The range was controlled by four simultaneously activated drag brakes which extended and retracted three times during the upward leg of the missile trajectory. The time that the brakes remained extended was determined by an internal computer which continuously compared the actual position and velocity of the rocket, as determined by an inertial platform, with the reference trajectory that the missile should be following for that particular range.

Time of flight varied between 120 and 200 seconds. About 22 seconds prior to impact, an arming decision was made, based on establishment of the square or window in space through which the missile would have to pass in order to receive an affirmative arming command. During the final 20 seconds of flight any necessary corrective maneuvers were performed.

The nose section for the warhead would have an overall length of 139 inches, with the base of the section having a diameter of 31 inches and tapering to a point. The warhead installation would be limited to a weight of 1500 pounds, of which 1250 pounds were allocated for the warhead. The warhead itself could have a maximum length of 65 inches.

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Warhead installation flights would start in April 1958, final systems demonstration of

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The Assistant Secretary of Defense notified the United States Atomic Energy Commission, October 10, 1958, that some time had passed since the Joint Chiefs of Staff had established a military requirement for a nuclear warhead for SERGEANT, but that a request for warhead development had been delayed pending a decision on the missile system itself.

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The Army would be the cognizant agent for the Department of Defense portion of the development, with normal Armed Forces Special Weapons Project participation.[13]

A Joint AEC/DOD Warhead Committee for SERGEANT was appointed and held its first meeting November 17, 1958. It was noted that the missile was in an advanced state of development and it appeared likely that the warhead flight-test program could proceed without major interruptions.

It was reported that considerable work had been accomplished on the missile fuzing system, but this had been designed to meet TX-43 requirements and might not be entirely applicable. There would be two options, air burst and contact burst, but no contact backup for the air-burst option. The fuze would be baro-armed and radar-fired in the air-burst option. Both impact crystals and crush switches would be considered for contact fuzing. At an altitude of 18,500 feet above the firing altitude, a baro offset switch would interrogate an arming-decision device to determine whether it was safe to arm the warhead. If trajectory and attitude were within limits, arming and firing signals would be generated in proper sequence.[14]

A SERGEANT meeting was held December 11-12, 1958. There was general agreement by all except Picatinny that a self-destruct feature was not desired. Development time scales were felt reasonable, with the exception of early flight-test dates which might be difficult to meet. The warhead would be design released in May 1960, with early production in May 1961, and would achieve operational capability in August 1961. Sandia proposed that a chopper-converter system be used. This would be a two-channel system, each channel of which would require a separate arming and charging signal. It was felt that a trajectory sensing or goof-proof device should be included, to provide ground handling safety.[15]

Sandia notified Albuquerque Operations Office, January 19, 1959, that it appeared entirely feasible to develop a warhead for the SERGEANT by August 1961, but that no firm commitment would be made until military characteristics had been received and evaluated.

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Military characteristics for the XW-52/SERGEANT were approved by the Military Liaison Committee January 20, 1959.

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Development authorization was released February 27, 1959.[18]

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Sandia forwarded the development program definition of the warhead to Albuquerque Operations Office April 22, 1959.

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Power would be supplied by the missile adaption kit. Sandia felt that the military characteristics required certain features that might limit use of the warhead for other applications or might compromise reliability, or were more appropriately adaption-kit requirements, and recommended changes were being discussed.[21]

Sandia wrote to the Division of Military Application April 29, 1959, commenting on the military characteristics. These characteristics had been prepared especially for the SERGEANT warhead, but it was felt that the size, shape and weight of the warhead should be optimized for other possible applications.[22]

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Since the missile system would not arm the warhead until the missile had entered the intended target area, there appeared to be no portion of the trajectory during which the proposed self-destruct system would be useful, and it was suggested that this requirement be deleted.

The option of air burst with contact preclusion was unclear, as both fuze and warhead attributes were involved, and contact-burst preclusion could be accomplished by the fuze. Since the warhead contained no energy source, it would be electrically inert and could be protected against accidental inputs by a handling safety device. This device would interrupt the power line from the adaption kit to the warhead and thus should be part of the Army's adaption kit. The warhead would have inaccessible trajectory-sensing devices, such as integrating accelerometers, and it was felt that caps that could be locked would provide no more safety than the use of caps having safety seals.[23]

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The higher yield weapon would have a maximum length of 65 inches and weigh not over 1200 pounds.[24]

Field Command notified Sandia January 9, 1961 that Report SC4445(WD), Proposed Ordnance Characteristics for the XW-52-X1 Warhead, had been reviewed in coordination with representatives of the interested Services. This review established that the design met all requirements of the military characteristics, with two exceptions. There was no provision for integral shielding against neutron radiation, but this had been accepted by the Army. Capability of monitoring the safe condition of the environmental sensing device would depend on current negotiations with the Army. The report had been accepted by the Design Review and Acceptance Group and was subsequently forwarded to the Division of Military Application.[32,33]

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The first XW-52-X1 Warhead tested was flown at the White Sands Missile Range March 10, 1961. The trajectory was low and the impact point about a kilometer short of the intended target.[35] Following this, three successful flights were staged in May 1961, and the balance of two flights was delayed pending availability of missiles.[36] These two flights were held in October 1961 and were successful.[37,38]

Static and centrifuge tests had meanwhile shown that the warhead design was more than adequate, and structural evaluation noted that the design could successfully withstand all handling and transportation loads, as well as carriage in the SERGEANT missile.[39] Engineering release of the Mk 52 Mod 1/SERGEANT was accomplished June 1961 on schedule, and early production achieved May 1962.

The Mk 52 Mod 2 Warhead was released January 28, 1963. This differed from the Mk 52 Mod 1 in that it incorporated a prescribed-action-link device, and entered production in February 1963.[40]

Sandia forwarded SC4715(WD), Final Report for the Mk 52 Mod 1 Warhead, to the Division of Military Application March 5, 1963. The report had been presented to and accepted by the Design Review and Acceptance Group. The warhead diameter was 24 inches, length 56.72 inches, and weight 925 pounds.

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Glossary of Mk 52 Terms

Accelerometer, Integrating -- A device for measuring acceleration, capable of summing the total acceleration in any given direction.

Adaption Kit -- Those items peculiar to the warhead installation less the warhead; namely, the arming and fuzing systems, power supply, and all hardware, adapters, and the like, required by a particular installation. Adaption-kit components are normally grouped into a complement, radars (if used), and power supply (if required).

Albuquerque Operations Office -- Change of name for the Santa Fe Operations Office, effective April 2, 1956.

Armed Forces Special Weapons Project -- An interdepartmental agency formed to handle military functions related to atomic weapons.

Arming -- The act of arming a weapon, that is, preparing it for firing.

Assistant Secretary of Defense -- Created by Department of Defense Directive, June 30, 1953, as part of DOD reorganization. Handles research and development activities of the DOD.

Barometric Fuze -- Fuze incorporating a baroswitch. A pressure device actuated by increasing air pressure as the weapon descends in its trajectory.

Boosting -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase the fission activity.

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Department of Defense -- The Armed Forces, i.e., the Army, Navy and Air Force.

Design Review and Acceptance Group -- A Military committee established to review the design of a specific weapon.

Detonators -- Explosive devices which, when initiated ~~(see bridge wires)~~ by the X-unit, ignite the lens charges of the high-explosive sphere (which see).

Deuterium -- The hydrogen isotope of mass number 2.

Director of Defense Research and Engineering -- Change of name for the Assistant Secretary of Defense.

Division of Military Application -- An AEC office that functions as liaison between the Military and weapons designers and producers.

Environmental Sensing Device -- A device that reacts to a specific environment of the weapon, such as speed, acceleration, altitude, etc.

Field Command -- The local office of the Armed Forces Special Weapons Project, located on Sandia Base, Albuquerque, New Mexico.

Firing System -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

Fuze -- A combination of the arming and firing devices of a weapon.

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Hardtack -- A nuclear series of 72 tests. Hardtack I was held at the Pacific Proving Grounds from April 28 to August 18, 1958. The decision to declare a moratorium on testing resulted in Hardtack II, held at the Nevada Test Site between September 12 and October 30, 1958.

High-Explosive Sphere -- The ball of high explosive that surrounds the nuclear primary and is designed to produce the implosion effect when detonated.

Implosion -- The effect created when a sphere of high explosive is detonated on its exterior surface. If suitable lens charges are provided to invert the explosion, the force of the shock wave is directed largely toward the center of the sphere.

Inertial Switch -- A switch containing a small weight and a spring. When subjected to an external force of acceleration or deceleration, the weight compresses the spring. Generally, a metering device is added to measure the length of time the external force is applied.

Joint Chiefs of Staff -- A group composed of the Chiefs of Staff of the Army, Navy and Air Force, to determine policy and develop joint strategic objectives of the Armed Forces.

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Los Alamos Scientific Laboratory -- A nuclear design organization located at Los Alamos, New Mexico.

Megaton -- A measure of yield of a large weapon. One megaton is the equivalent of 1,000,000 tons of high explosive.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense Committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

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Radar -- Name for Radio Detecting and Ranging. Radars emit a pulse of high-frequency energy and measure the time lapse from that transmission to receipt of a reflected electrical "echo" from an object. This time measurement determines the distance of the object from the transmitting antenna of the radar.

Reservoir -- As used in this history, a container for deuterium-tritium boosting gas.

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Thermonuclear -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

Thyratron -- A grid-controlled electron tube.

Ton (Yield) -- *A means of measuring the yield of an atomic bomb by comparing its* output with the effect of an explosion of TNT. A 1-ton yield is equivalent to the detonation effect of 2000 pounds of high explosive.

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